

## CLAIMS

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said substrate; and

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electricity is liable to be discharged in various processes after said electric field applying process including said electron emission portion forming process, or when said electron beam device is used, to  
5 thereby change said portion into a shape which is difficult to discharge electricity.

4. The method of manufacturing the electron beam device according to claim 1, characterized in that  
10 said electron emission portion forming step includes an electrode forming step of forming a pair of electrodes to which different potentials are given from said wirings in correspondence with said respective electron emission portions, and said electric field applying  
15 step is conducted before said electrode forming step is conducted.

5. The method of manufacturing the electron beam device according to claim 4, characterized in that  
20 said pair of electrodes comprise a pair of electrodes that constitute surface conduction type electron emission elements.

6. The method of manufacturing the electron beam device according to claim 5, characterized in that  
25 said electrode forming step comprises a step which includes a thin film forming step of forming an

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electrically conductive thin film on said substrate,  
and produces a gap in said formed electrically  
conductive thin film and constitutes said pair of  
electrodes by said electrically conductive thin films  
5 which exists on both sides of said gap.

7. The method of manufacturing the electron  
beam device according to claim 6, characterized in that  
said electric field applying step is conducted before  
10 said thin film forming step is conducted.

8. The method of manufacturing the electron  
beam device according to claim 6, characterized in that  
said electric field applying step is conducted after  
15 said thin film forming step is completed and before the  
gap is produced in said electrically conductive thin  
film.

9. The method of manufacturing the electron  
20 beam device according to claim 4, characterized in that  
said pair of electrodes comprise an emitter and a gate  
of the electric field emission type electron emission  
element.

25 10. The method of manufacturing the electron  
beam device according to claim 9, characterized in that  
said electric field emission type electron emission

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element comprises said emitter that emits electrons from an end portion and said gate that produces an electric field between said end portion and said gate.

5           11. The method of manufacturing the electron beam device according to claim 9 or 10, characterized in that said electric field applying step is conducted before said emitter is formed.

10           12. The method of manufacturing the electron beam device according to claim 11, characterized in that said electric field applying step is conducted before said gate is formed.

15           13. The method of manufacturing the electron beam device according to claim 12, characterized in that said plurality of electron emission portions are connected onto one main surface of said substrate in the form of a ladder or a matrix by said wirings.

20           14. The method of manufacturing the electron beam device according to claim 13, characterized in that, in said electric field applying step, an electrode is disposed opposite to a surface of said  
25 substrate on which said wirings are disposed, and a voltage is applied between said electrode and the wirings on said substrate to apply said electric field.

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electrically connected to each of said element  
electrodes, and an electron emission portion formed on  
a part of said electrically conductive thin film are  
formed on the same substrate, and said element  
5 electrodes of said respective electron source elements  
are connected in the form of a ladder or a matrix by  
wirings; and an image forming member disposed opposite  
to said electron source on said substrate, said method  
characterized by comprising: an electric field applying  
10 step of applying a given electric field to said  
substrate on which said wirings are formed after a step  
of forming said wirings is completed and before a step  
of forming said electron emission portions is  
completed.

15  
20. The method of manufacturing an image  
forming apparatus according to claim 19, characterized  
in that a control electrode which controls the electron  
beam emitted from said respective electron source  
20 elements in response to an information signal is  
combined.

21. The method of manufacturing an electron  
beam device according to claim 1, characterized in that  
25 said electric field applying step is conducted in such  
a manner that said electrode for applying the electric  
field and said substrate are disposed opposite to each

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other to apply a voltage between said electrode and  
said wirings, and an energy stored in the capacitor  
formed of said electrode and said substrate is equal to  
or less than an energy that destroys said electrically  
5       conductive thin film.

22. A method of manufacturing an electron beam  
device that includes a plurality of surface conduction  
type electron emission elements, said method  
10       characterized by comprising:

          a step of forming plural pairs of element  
electrodes on a substrate;

          a step of connecting a plurality of row-  
directional wirings and a plurality of column-  
15       directional wirings which are stacked one on another  
through an insulating layer to the respective  
electrodes of said plural pairs of element electrodes  
to form common wirings in a matrix;

          a step of forming electrically conductive thin  
20       films between each pair of element electrodes;

          a forming step of forming electron emission  
portions by conducting an electrifying process on said  
electrically conductive thin films between each pair of  
element electrodes; and

25       a conditioning step of applying said electric  
field by applying a voltage between said electrode and  
said common wiring in which an electrode for applying

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an electric field to a surface having said common wirings and said substrate are disposed opposite to each other;

wherein said conditioning step is conducted  
5 under the condition where an energy stored in a capacitor formed of said electrode and said substrate is equal to or less than an energy that destroys said electrically conductive thin film.

10 23. The method of manufacturing an electron beam device according to claim 22, characterized in that, assuming that an area where said electrode and said substrate face each other is S, a distance between said electrode and said substrate is Hc, a voltage  
15 applied between said electrode and said common wiring is Vc, a dielectric constant of vacuum is  $\epsilon$ , and an energy by which said electrically conductive thin film is destroyed is Eth, said conditioning step is conducted under the following condition:

20 
$$\epsilon \times S \times Vc^2 / 2Hc < Eth \quad \dots\dots(1)$$

24. The method of manufacturing an electron beam device according to claim 22, characterized in that a plurality of electrodes for applying said  
25 electric field are used in said conditioning step.

25. The method of manufacturing an electron

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beam device according to claim 22, characterized in that a relative position between said electrode and said substrate is changed in said conditioning step.

5                   26. A method of manufacturing an image forming apparatus that includes a substrate on which a plurality of surface conduction type electron emission elements are formed, and an image forming member which is disposed opposite to said surface conduction type  
10 electron emission elements on said substrate, said method characterized by comprising:

                  a step of forming plural pairs of element electrodes on a substrate;

                  a step of connecting a plurality of row-  
15 directional wirings and a plurality of column-directional wirings which are stacked one on another through an insulating layer to the respective electrodes of said plural pairs of element electrodes to form common wirings in a matrix;

20                   a step of forming electrically conductive thin films between each pair of element electrodes;

                  a forming step of forming electron emission portions by conducting an electrifying process on said electrically conductive thin films between each pair of  
25 element electrodes; and

                  a conditioning step of applying said electric field by applying a voltage between said electrode and

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said common wiring in which an electrode for applying an electric field to a surface having said common wirings and said substrate are disposed opposite to each other;

5                wherein said conditioning step is conducted under the condition where an energy stored in a capacitor formed of said electrode and said substrate is equal to or less than an energy that destroys said electrically conductive thin film.

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27. A method of manufacturing an electron beam device that includes a first plate with an electron beam source which generates an electron beam, said method characterized by comprising:

15                a step of applying a voltage between said first plate and an electrode which is opposite to said first plate;

                 wherein in said step, a voltage that allows a leader current to flow is applied between said first  
20                plate and an electrode which is opposite to said first plate.

28. The method of manufacturing an electron beam device according to claim 27, characterized in  
25                that said voltage is a voltage which can maintain a state in which said leader current flows.

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31. The method of manufacturing an image forming apparatus according to claim 30, characterized in that said high voltage applying step is conducted on a rear plate substrate on which said electrode is

formed before an electron beam source is completed.

32. The method of manufacturing an image forming apparatus according to claim 30, characterized in that said high voltage applying step is conducted in vacuum.

33. The method of manufacturing an image forming apparatus according to claim 30, characterized in that said high voltage applying step is conducted in gas.

34. The method of manufacturing an image forming apparatus according to claim 30, characterized in that a high voltage is applied between said substrate on which said electrode is formed and a dummy face plate with a counter electrode.

35. The method of manufacturing an image forming apparatus according to claim 30, characterized in that said substrate on which said electrode is formed has a feeder wiring to the electron emission element, and the high voltage is applied with the wiring as one electrode and the dummy face plate as the other electrode.

36. The method of manufacturing an image

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forming apparatus according to claim 30, characterized  
in that said substrate on which said electrode is  
formed has a plurality of row-directional wirings and a  
plurality of column-directional elements for feeder so  
5 as to wire a plurality of electron emission elements in  
a matrix, all of the row-directional wirings and the  
column-directional wirings are made common wiring, and  
the high voltage is applied with the row-directional  
and column-directional wirings as one electrode and the  
10 dummy face plate as the other electrode.

37. The method of manufacturing an image  
forming apparatus according to claim 30, characterized  
in that said high voltage is a d.c. voltage that  
15 gradually steps up from a low voltage.

38. The method of manufacturing an image  
forming apparatus according to claim 30, characterized  
in that said high voltage is an a.c. voltage that  
20 gradually steps up from a low voltage.

39. The method of manufacturing an image  
forming apparatus according to claim 30, characterized  
in that said high voltage is a pulse voltage that  
25 gradually steps up from a low voltage.

40. The method of manufacturing an image

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forming apparatus according to claim 30, characterized in that said electron beam source is a cold cathode element.

5                   41. The method of manufacturing an image forming apparatus according to claim 30, characterized in that said electron beam source is a surface conduction type emission element.

10                   42. A method of manufacturing an image forming apparatus that includes a rear plate with an electron beam source, a face plate on which a phosphor that emits a light by irradiation of an electron beam is formed, and a structure support disposed between said  
15 rear plate and said face plate, said method characterized by comprising:

                  a step of applying a high voltage between said face plate and said rear plate after said face plate, said rear plate and said structure support are  
20 assembled together into a panel; and

                  a step of forming an electron source after said high voltage applying step.

25                   43. The method of manufacturing an image forming apparatus according to claim 42, characterized in that said high voltage applying step is conducted in vacuum.

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5                   48. The method of manufacturing an image  
forming apparatus according to claim 47, characterized  
in that said structure support is disposed between said  
electron beam source and said face plate so that its  
longitudinal direction is in parallel with any one of  
0   said plurality of row-directional wirings and said  
plurality of column-directional wirings.

50. The method of manufacturing an image forming apparatus according to claim 42, characterized in that said high voltage is a pulse voltage with a peak value of which gradually steps up from a low voltage.

25            51. The method of manufacturing an image  
forming apparatus according to claim 42, characterized  
in that said high voltage is a monotonic increase



52. The method of manufacturing an image forming apparatus according to claim 42, characterized in that said electron beam source is a cold cathode element.

54. The method of manufacturing an image forming apparatus according to claim 53, characterized in that said electron source forming step includes an electrification forming step.

55. The method of manufacturing an image forming apparatus according to claim 53, characterized in that said electron source forming step includes an electrification activating step.

56. A method of manufacturing an electron beam device that includes a first plate with an electron beam source which generates an electron beam and an electrode which is opposite to said first plate, said method characterized by comprising:

a first step of applying a voltage between said first plate and said electrode; and

a step of forming said electron beam source after said first step.

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57. The method of manufacturing an electron beam device according to claim 56, characterized in that said electron beam source forming step conducted after said first step comprises a step of forming a high resistant portion on an electrically conductive film by electrifying said electrically conductive film.

58. The method of manufacturing an electron beam device according to claim 56, characterized in that said electron beam source forming step after said first step comprises a step of depositing a deposit on an electron emission portion, a portion close to the electron emission portion, or said electron emission portion and said portion close to the electron emission portion.

59. The method of manufacturing an image forming apparatus according to claim 56, characterized in that said first step is conducted after wirings are formed on said first plate.

60. The method of manufacturing an electron

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a third conditioning step conducted by an electrode with a sheet resistance of which is larger than that in said second conditioning step after said

electron emission portion forming step; and

a fourth conditioning step conducted by an electrode with a sheet resistance of which is smaller than that in said first conditioning step after said third conditioning step.

66. A method of manufacturing an image forming apparatus including a conditioning step of disposing an electrode at a position opposite to an anode substrate that constitutes an anode and applying a high voltage between said electrode and an anode substrate in a step of manufacturing said anode that constitutes an image forming apparatus, said method characterized by further comprising:

plural kinds of conditioning steps where the sheet resistances of said electrodes are different, respectively.

67. The method of manufacturing an image forming apparatus according to claim 66, characterized in that a high voltage is applied between said anode substrate and said electrode with said anode substrate side as an anode.

68. The method of manufacturing an image forming apparatus according to claim 66, characterized by further comprising: a fluorescent film forming step

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opposite to said cathode substrate, characterized in  
that a high voltage is applied to an anode disposed  
opposite to said cathode substrate with said cathode  
substrate as a cathode, and abnormal discharge  
5 generated by application of said high voltage is  
detected to suppress said abnormal discharge during  
manufacturing of said cathode substrate.

72. A method of manufacturing a plate type  
10 image forming apparatus that includes a cathode  
substrate on which an electron beam source is disposed,  
and an image formation anode substrate disposed  
opposite to said cathode substrate, characterized in  
that a high voltage is applied to an anode disposed  
15 opposite to said cathode substrate with said cathode  
substrate as a cathode, and abnormal discharge  
generated by application of said high voltage is  
detected, and the potential of said anode is allowed to  
approach the potential of said cathode to suppress said  
20 abnormal discharge during manufacturing of said cathode  
substrate.

73. The method of manufacturing an image  
forming apparatus according to claim 71, characterized  
25 in that the abnormal discharge is detected to  
electrically cut off said anode and the high voltage  
power supply connected to said anode.

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74. The method of manufacturing an image forming apparatus according to claim 71, characterized in that said cathode substrate is a plurality of surface conduction type electron emission elements disposed in a matrix as said electron source.

75. A device for manufacturing a plate type image forming apparatus including a cathode substrate on which an electron beam source is disposed, and an image formation anode substrate disposed opposite to said cathode substrate, said device comprising:

an anode;

a high voltage power supply connected to said anode; and

detecting means for detecting abnormal discharge generated between said anode and a cathode disposed opposite to said anode by application of a high voltage from said high voltage power supply;

wherein the high voltage is applied between said cathode substrate disposed as said cathode and said anode by said high voltage power supply, and the generated abnormal discharge is detected by said detecting means to suppress said abnormal discharge during manufacturing of said cathode substrate.

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76. A device for manufacturing a plate type image forming apparatus including a cathode substrate

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on which an electron beam source is disposed, and an image formation anode substrate disposed opposite to said cathode substrate, said device comprising:

an anode;

5           a high voltage power supply connected to said anode; and

          detecting means for detecting abnormal discharge generated between said anode and a cathode disposed opposite to said anode by application of a  
10          high voltage from said high voltage power supply;

          wherein the high voltage is applied between said cathode substrate disposed as said cathode and said anode by said high voltage power supply, and the generated abnormal discharge is detected by said  
15          detecting means, and the potential of said anode is allowed to approach the potential of said cathode to suppress said abnormal discharge during manufacturing of said cathode substrate.

20                 77. The device for manufacturing an image forming apparatus according to claim 75 or 76, characterized by further comprising means for electrically cutting off said anode and said high voltage power supply connected to said anode on the  
25          basis of the detection of the abnormal discharge by said detecting means.

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applying an electric field in a direction substantially perpendicular to a surface of said substrate on which at least said wirings and said electrodes are formed where said electron emission elements are formed (conditioning step);

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83. The method of manufacturing an electron source according to claim 82, characterized in that said conditioning step is conducted after said step of forming said wirings and said electrodes on said substrate, and thereafter said step of forming said electrically conductive film is conducted.

84. The method of manufacturing an electron source according to claim 82, characterized in that said conditioning step comprises: a first conditioning step conducted after said step of forming said wirings and said electrodes on said substrate and before said electrically conductive film forming step; and a second conditioning step conducted after said electrically conductive film forming step and before said forming step;

wherein assuming that the sheet resistances of said conditioning electrode when conducting said first and second conditioning steps are  $R_1$  and  $R_2$ , respectively, the values  $R_1$  and  $R_2$  satisfy  $R_1 < R_2$ .

85. The method of manufacturing an electron source according to claim 84, characterized by further comprising a third conditioning step of disposing said conditioning electrode opposite to a surface of said substrate on which said electrodes and said wirings are formed at an interval and applying a voltage between

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said conditioning electrode and said substrate, to  
apply an electric field in a direction substantially  
perpendicular to the surface of said substrate on which  
said electron emission elements are formed after said  
5 forming step and before said activating step;

wherein the sheet resistance R3 of said  
conditioning electrode satisfies  $R2 < R3$ .

86. The method of manufacturing an electron  
10 source according to claim 85, characterized by further  
comprising a fourth conditioning step of disposing said  
conditioning electrode opposite to a surface of said  
substrate on which said electrodes and said wirings are  
formed at an interval, and applying a voltage between  
15 said conditioning electrode and said substrate, to  
apply an electric field in a direction substantially  
perpendicular to the surface of said substrate on which  
said electron emission elements are formed after said  
activating step,

20 wherein the sheet resistance R4 of said  
conditioning electrode satisfies  $R4 < R1$ .

87. The method of manufacturing an electron  
source according to claim 82, characterized in that  
25 said conditioning step is executed while a leader  
phenomenon of the discharge between said conditioning  
electrode and said substrate is monitored, and control

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90. The method of manufacturing an electron source according to claim 82, characterized in that said conditioning step is executed while an interval between said conditioning electrode and said substrate is changed.

91. A method of manufacturing an image forming apparatus including an electron source having a plurality of electron emission elements and wirings connected to said electron emission elements, and an image forming member which forms an image by irradiation of an electron beam emitted from said electron source on a substrate, said electron source and said image forming member being disposed opposite to each other within an airtight vessel, in which each of said electron emission elements includes a pair of opposite electrodes disposed on said substrate, an electrically conductive film connected to said electrodes and having a first crack in a region between said electrodes, and a deposit mainly containing carbon, having a second crack narrower than said first crack within said first crack and disposed within said first crack and in the region of said electrically conductive film including said first crack, said method characterized by comprising the steps of:

forming said wirings and said electrodes on said substrate;

forming said electrically conductive film;

forming said first crack in said electrically  
conductive film (forming step);

forming said deposit mainly containing carbon  
5 (activating step), said activating step being conducted  
after said forming step; and

applying an electric field in a direction  
substantially perpendicular to a surface of said  
substrate on which at least said wirings and said  
10 electrodes are formed where said electron emission  
elements are formed (conditioning step); and

assembling said airtight vessel so as to  
include said electron source and said image forming  
apparatus therein;

15 wherein said conditioning step is executed by  
applying a voltage between said image forming member  
and said substrate after said step of assembling said  
airtight vessel and before said forming step.

20 92. The method of manufacturing an image  
forming apparatus according to claim 91, characterized  
in that said conditioning step is executed while a  
leader phenomenon of the discharge between said image  
forming member and said substrate is monitored, and  
25 control under which the potential of said image forming  
member is allowed to approach the potential of said  
substrate is conducted when said leader phenomenon is

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detected.

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5 93. The method of manufacturing an image forming apparatus according to claim 91, characterized in that said conditioning step is executed while voltage supply means is connected between said image forming member and said substrate, a leader phenomenon of the discharge between said image forming member and said substrate is monitored, and control for cutting off the connection between said image forming member and said voltage applying means is conducted when said leader phenomenon is detected.

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15 94. A manufacturing apparatus for executing said electron source manufacturing method according to claim 89, characterized in that an area of said conditioning electrode opposite to said substrate is smaller than an area of the surface of said substrate on which said electron emission elements are disposed, and there is provided moving means for moving said conditioning electrode while an interval between said conditioning electrode and said substrate is held to a given value.

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25 95. A manufacturing apparatus for executing the electron source manufacturing method according to claim 90, characterized by comprising interval control

means for controlling the interval between said conditioning electrode and said substrate in said conditioning step.

5                   96. A manufacturing apparatus for executing said electron source manufacturing method according to claim 87, characterized by comprising monitoring means for monitoring a leader phenomenon of the discharge between said conditioning electrode and said substrate;  
10                   and

                  potential changing means for making the potential of said conditioning electrode approach the potential of said substrate on the basis of a signal indicating that said monitoring means detects said  
15                   leader phenomenon.

                  97. The manufacturing apparatus for an electron source according to claim 96, characterized in that said potential changing means comprises a switch  
20                   for turning on/off a circuit that short-circuits between said conditioning electrode and said substrate.

                  98. A manufacturing apparatus for executing said image forming apparatus manufacturing method  
25                   according to claim 92, characterized by comprising:  
                  monitoring means for monitoring a leader phenomenon of the discharge between said image forming

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potential changing means for making the potential of said image forming member approach the potential of said substrate on the basis of a signal  
5 indicating that said monitoring means detects said leader phenomenon.

99. The manufacturing apparatus for an image forming apparatus according to claim 97, characterized in that said potential changing means comprises a switch for turning on/off a circuit that short-circuits between said image forming member and said substrate.

100. A manufacturing apparatus for executing  
15 said electron source manufacturing method according to  
claim 88, characterized by comprising:

monitoring means for monitoring a leader phenomenon of the discharge between said conditioning electrode and said substrate; and

20 connection cutoff means for cutting off the electric connection between said conditioning electrode and said voltage applying device on the basis of a signal indicating that said monitoring means has detected said leader phenomenon.

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101. A manufacturing apparatus for executing  
said image forming apparatus manufacturing method

according to claim 93, characterized by comprising:

monitoring means for monitoring a leader  
phenomenon of the discharge between said image forming  
member and said substrate; and

5 connection cutoff means for cutting off the  
electric connection between said image forming member  
and said voltage applying device on the basis of a  
signal indicating that said monitoring means has  
detected said leader phenomenon.

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